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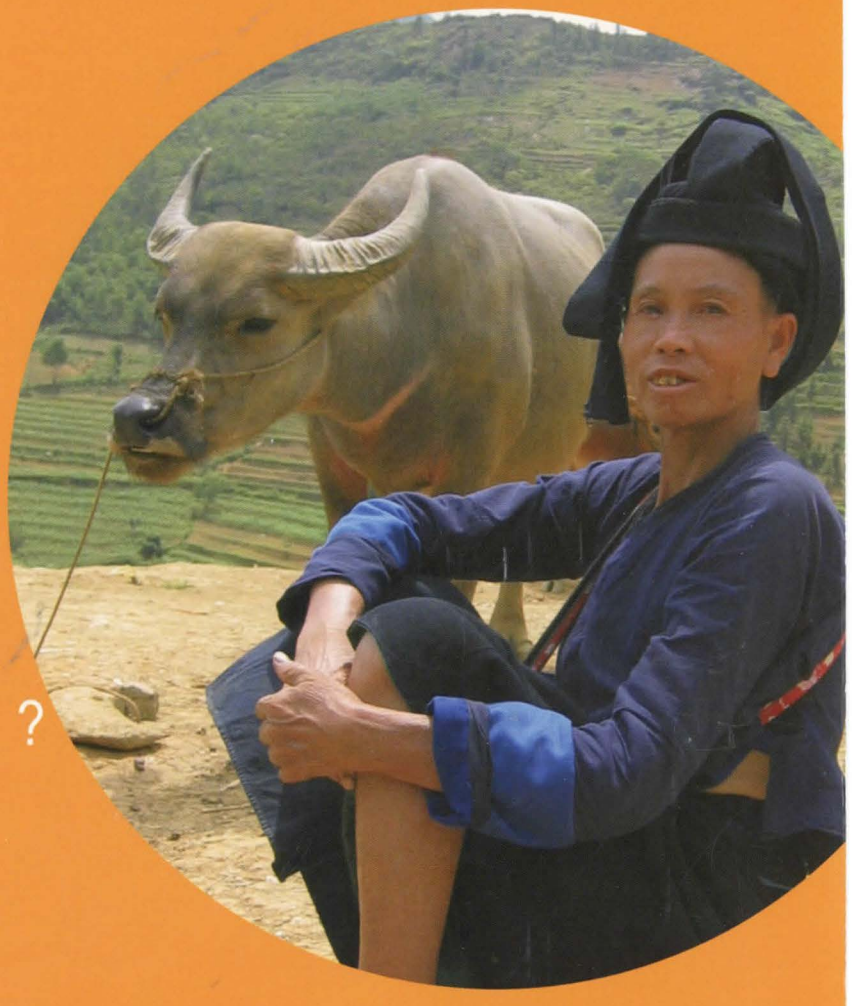

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EFFECTS OF SOCIAL INTERACTIONS ON THE REPRODUCTION OF THE NILE TILAPIA, *OREOCHROMIS NILOTICUS*: POSSIBLE APPLICATION FOR BREEDER MANAGEMENT

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ABSTRACT

Behaviour and social factors are important for the reproduction of *O. niloticus*. The influence of social interactions on the fry production was analyzed using a domestic strain. In a first step (S1), females with high and low reproductive potential (HRP and LRP) were detected within a group of breeders. Two groups (G1 and G2) were constituted with a sex ratio of 3 males / 7 females (1:2.3). G1 presented a significant difference in the average spawning rate of HRP and LRP females (3.5 ± 0.58 and 0.33 ± 0.58 spawns.female^{-1} respectively). We then carried out social reorganizations based on the previously established (S1) reproductive potential (RP). Two groups (GA and GB) with FRP (sex ratio: 1:3) and HRP females (sex ratio: 1:4) respectively were constituted using the G1 breeders. These social reorganizations have strongly affected individual RP and the dominance (aggressiveness) of some LRP females. Within GB, the average spawning number decreased from 3.5 ± 0.58 to 0.75 ± 0.96 spawns.female^{-1}. These results suggest a strong influence of behavioural and social components in the RP of breeders. Interestingly, some HRP females retain their high RP following a social reorganization.

INTRODUCTION

Within the *Oreochromis* genus (Tilapia), reproduction is influenced by many environmental factors such as temperature, photoperiod, density, sex-ratio, size and weight of breeders, food, stress, oxygen, salinity, pH, ... (Mires, 1982; Baroiller *et al.*, 1997). In these species, within a group of breeders social factors and hierarchical organisation can strongly influence the reproductive potential (RP) of females. The

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reproductive investment is very variable according to the females; some females seem to spawn much more than others (Mires, 1982; Baroiller *et al.*, 1997; Desprez and Mélard, 1998). The objective of this study was to analyze the individual RP evolution of females within a group of breeders before and after their social reorganization. The finality of the study was a possible transfer to aquaculture for improving breeder management and optimizing the reproduction yield.

MATERIEL AND METHODS

This study was carried out within Cirad-Gamet rearing structures. *Oreochromis niloticus* ("Bouaké" strain) individuals were maintained in tanks (2x1x0.35 m and 0.7 m^3), under controlled temperature (27.7°C ± 0.4 °C) and photoperiod (13L: 11D). The fish were individually tagged with Pit-tags (Passive integrated transponder). Before each harvest, the fish were anaesthetized with 2-phenoxyethanol for collecting eggs or fry in the mouth of females. Each collected progeny was characterized by its egg/fry number and development stages, its mother tag number and weight. In a preliminary study, a nine-month survey of reproduction activity has been carried out within a group of breeders (5 males/10 females) reared under similar controlled conditions. Every 10 days, each individually tagged female was checked for the presence of eggs/fry in her mouth. A two-step experimentation was carried out to confirm the results of the preliminary experimentation.

Stage 1 (S1): females with high or low RP (HRP and LRP) were identified within 2 groups (G1 and G2) of breeders (sex-ratio of 3 males/7 females = 1: 2.3) checked every 7 days during 9 weeks for the presence of eggs/fry in the mouth of each female.

Stage 2 (S2): within these groups of breeders, effects of social factors on fish reproduction were analyzed through social reorganizations based on previously established (during S1) reproductive potential (RP): two groups (GA and GB) of FRP (sex ratio: 1:3) and HRP (sex ratio: 1:4) respectively were constituted using the G1 breeders. They were checked every 7 days during 5 weeks for the presence of eggs/fry in the female mouths.

Data analysis: Results are expressed as the average and standard deviation (SD). Student test (t test) was used to determine differences in average values (significance level: $P<0.05$).

RESULTS

Preliminary study: within the 9-month period, 51 spawns were obtained with variable reproductive investments according to the females (1-9 spawns/female): 51% of the spawns were produced by only 3 females and 73% by 5 females.

Stage 1: 4 HRP and 3 LRP have been identified within G1 (Table 1). In this group, 93.3% of the spawns were carried out by HRP. The average number of spawns in HRP (3.5 ± 0.58 spawns.female^{-1}) was significantly higher than in LRP (0.33 ± 0.58 spawns.female^{-1}) (t. test; t = 7.18; df = 4.45; P<0.05). The difference in average absolute fecundity in HPR (1293.37 ± 780.85 eggs.spawn^{-1}) and FPR (1480 eggs. spawn^{-1}) was not significant (t. test; t = 1.27; df = 4.19; P>0.05). The mean relative fecundity was significantly higher in HRP than in LRP: 2726.68 ± 657.65 and 1687.75 eggs.spawn^{-1}.kg^{-1} respectively (t. test; t = 3.32; df = 3.34; P<0.05).

Table 1. Reproductive Performances in HRP and LRP females of group 1 breeders (G1) during stage 1 (S1).

G1	HRP	LRP
Mean body weight of females (g ± SD)	450.5 ± 199.03	945.41 ± 89.94
Number of spawns	14 (93.3 %)	1 (6.6 %)
Average number of spawns.female^{-1} ± SD	3.5 ± 0.58	0.33 ± 0.58
Rate of spawning females	100 %	33.33 %
Mean absolute fecundity (eggs.spawn^{-1} ± SD)	1293.37 ± 780.85	1480
Mean relative fecundity (eggs.spawn^{-1}.kg^{-1} of females ± SD)	2726.68 ± 657.65	1687.75

Stage 2: within the GA females, no spawns were observed due to the aggressiveness of a female against the other fish of this group: 2/3 females of this group were thus killed. Spawning frequency was lower in GB than in G1. The reproduction performances of HRP were compared during the two steps (Table 2). The rate of spawning females decreased from 100% in G1 HRP (S1) to 33.3% in GB females (S2). The average spawning number of HRP significantly decreased between the two steps, from 3.5 ± 0.58 in S1 to 0.75 ± 0.96 spawns.female^{-1} in S2 (t. test; t = 4.91; df = 4.93; P<0.05). The mean absolute fecundity did not change significantly, between S1 (1293.37 ± 780.85 eggs.spawn^{-1}) and S2

(1152.5 ± 456.08 eggs.spawn^{-1}) (t. test; t = 1.35; df = 5.95; P>0.05). The mean relative fecundity was not significantly modified between S1 (2726.68 ± 657.65 eggs.spawn^{-1}.kg^{-1}) and S2 (2208.52 ± 348.38 eggs.spawn^{-1}.kg^{-1}) of female during S2 (t. test; t = 1.23; df = 5.95; P>0.05).

Table 2. Comparison of group 1 (G1) HRP of stage 1 (S1) and Group B from stage 2 (S2) females.

Stage	S1 : G1 (HRP)	S2 : GB
Mean body weight of females (g ± SD)	450.5 ± 199.03	538.95 ± 224.89
Mean number of spawns.females^{-1} ± SD	3.5 ± 0.58	0.75 ± 0.96
Rate of spawning females	100 %	33.33 %
Mean absolute fecundity (eggs.spawn^{-1} ± SD)	1293.37 ± 780.85	1152.5 ± 456.08
Mean relative fecundity (eggs.spawn^{-1}.kg^{-1} of females ± SD)	2726.68 ± 657.65	2208.52 ± 348.38

DISCUSSION

The present study suggests an important influence of social factors and behaviour on *Oreochromis niloticus* reproduction. This type of influence has been suggested previously in order to explain the variations of spawning capacity seen in *Oreochromis* females (Mires, 1982; Desprez and Mélard, 1998). Under optimal conditions an *O. niloticus* female can reproduce naturally every 4 to 6 weeks (Ruwet *et al.*, 1976; Mélard and Philipart, 1981; Baroiller *et al.*, 1997). In the present study, the minimum interval separating 2 spawnings seems to be 2 weeks for *O. niloticus*. This short interval could be explained by the systematic eggs/fry removal from the mouth of females thus reducing the incubation period, stimulating the resumption of vitellogenesis within subsequent follicle wave of and then the individual spawning capacity (Verdegem and McGinty, 1978; Tacon *et al.*, 1996; Baroiller *et al.*, 1997). This study confirmed the existence of important variations of reproduction potentialities in *O. niloticus* females. They are observed on one hand, between females of a same group, with HRP and LRP; on the other hand, after social reorganization since RP was modified for some females (HRP or FRP). A similar difference in performance was also shown in *O. aureus* (a sister species to *O. niloticus*) under controlled conditions (Desprez *et al.*, 2007). A hierarchy established between females could be

at the origin of the inhibition of reproduction in part of these females (LRP). This hierarchy and this difference in spawning capacity were observed by Rothbard (1979) and Mires (1982) in *O. niloticus*, and by Desprez *et al.*, (2007) in *O. aureus*. The decrease of spawning performances observed in three HRP during the second step of our experimentation is in agreement with the assumption of an hierarchy leading to inhibitions. Nevertheless, one HRP female did preserved her RP and continued to spawn frequently. The isolation of HRP females can thus lead to the social reorganization of a group. However, Desprez *et al.*, (2007) using an important number of breeders, reported an increase in the RP of *O. aureus* HRP after their isolation. This difference of RP was expressed primarily in terms of relative fecundity. Indeed our results show a clear difference in terms of relative rather than in terms of absolute fecundity, the latter not being affected by social status. HRP females were characterized by their relative fecundity, whereas absolute fecundity was more determined by individual RP. As suggested by Mires (1982) and confirmed by this study, the RP of breeders depends on the spawning capacity and egg production (absolute fecundity). The appearance of an aggressive behaviour in GA LRP would be the consequence of eliminating the predominance exerted by HRP. This strengthens our hypothesis of a possible predominance of HRP. But the new dominant female did not spawn, raising the question of the relation between RP and domination character. Our preliminary results suggest that RP would mainly rely on the individual capacities of spawning and egg production rather than on the social status. Interestingly, some HRP females retain their high RP following a social reorganization.

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